ON THE PRODUCTION OF MESOTRONS BY NEUTRAL PARTICLES

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ABSTRACT. Schein, Jess and Wollan type of experiment to study the production of mesotrons by non-ionizing radiation was tried at a height of 16,800 ft at Bara Lacha (22.5°N) in British Lahaul. The production of mesotrons by non-ionizing cosmic rays does not become noticeable at these heights in intermediate latitudes as it does around the latitude of Chicago. The Mesotron producing layer in the atmosphere is at greater height in the equatorial regions.

It is now well known that the penetrating component of cosmic rays at sea level consists mainly of mesotrons and that these particles are secondaries produced by the soft component of cosmic radiation in upper layers of atmosphere. The mode of production of mesotrons has been a subject of interest for the past few years. It was thought that the progeneters of mesotrons were the non-ionizing soft cosmic rays. Rossi (1933) and Hsiung (1934) tried experiments at sea level and Shonka (1939) at an altitude of 14,200 feet. These experimenters got no definite evidence of their production, which would mean that between sea level and 14,200 ft. no detectable part of the mesotrons is being produced as secondaries from neutral cosmic radiation. This led Schein and Wilson (1939) to try Rossi-Hsiung type of experiment at still higher altitudes by taking their apparatus in an aeroplane up to 25,000 ft. Further heights were reached by Schein, Jesse and Wollan (1940) by means of baloon flights. The experiment of Schein and his collaborators showed that at higher altitudes the non-ionizing cosmic radiation produced mesotrons in a 2-cn lead block and that the production of mesotrons begins to be noticeable near about an altitude where the pressure is 40 cm of Hg.

All these experiments were tried at magnetic latitudes greater than 38° where the latitude knee occurs in the Intensity *vs* Latitude curve at sea level. One of us (1939) has shown that the temperature co-efficient of the intensity of cosmic rays is a function of latitude, the equatorial regions having a smaller temperature co-efficient. Blackett (1938) predicted this on the hypothesis that the mesotrons which constitute the penetrating cosmic rays are produced in the upper atmosphere by less penetrating radiation and that they show spontaneous disintegration. When the atmosphere expands at the higher temperature, the elevation at which the mesotron is produced is greater and there is a higher probability of spontaneous disintegration resulting in a lower intensity at sea level. At a latitude of about 38°, the altitude at which the mesotrons are created is a maximum of about 25 kilometers. At lower latitudes, *i.e.*, the latitude of Lahore (22° N) the

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maximum altitude of the layer of atmosphere where the mesotrons are created should be much higher. If at latitudes higher than 38° the production of mesotrons by neutral particles becomes noticeable at 16,000 ft. above sea level, their production will not be detectable at the same elevations around intermediate latitudes. With this in view an experiment similar to that of Schein, Jesse and Wollan was planned and tried at a height of 16,800 ft. by the side of a hill above Bara Lacha pass, in British Lahaul (22.5° N).

Four G-M counter tubes were placed in a verticle line as shown in fig. 1, Counters 1, 2 and 3, constitute one coincidence set, while counters 2, 3 and 4 make the other coincidence set. Any cosmic ray particle passing through either set must penetrate at least 8 cm. of lead, therefore the coincidences in both the sets are caused by penetrating particles. The lower set should ordinarily give slightly less counts, about one per cent less than the upper set due to the absorption of the incident mesotron in the last 2-cm block of lead. If mesotrons are produced in the first 2-cm lead block by non-ionizing radiation, the lower set of counters should count more coincidences than the upper one. To reduce the effect of softer horizontal air shower particles, a shield of 2 cm of lead is placed on the sides of counter 3.

Vertical line up of the counters

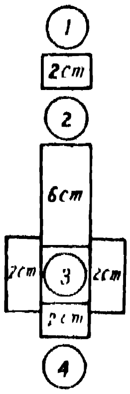

FIG. 1

Counters used are of self-quenching type. Each has a length of 6 inches and a diameter of 1 inch. All the G-M tubes had nearly the same plateau. At Zing Zing Bar (13,800 ft.) both the coincidence sets were tested for their efficiency. It was found that their efficiencies were practically the same. In one hour the upper set gave 176 counts and the lower set gave 177 counts.

RESULTS

TABLE I

Place	Total Time	A No. of counts in the upper set	B No. of counts in the lower set	A/B
Zing Zing Bar (13,800 ft.).	3 hours	282 ± 17	253 ± 16	$1.12 \pm \cdot 02$
Bara Lacha (16,800 ft.).	5 hours	547 ± 23	494 ± 21	$1.11 \pm \cdot 02$

The results at two different elevations are presented in Table I. The ratio of the number of counts in the upper set to the number of counts in the lower set at both the places show that in these latitudes the production of mesotrons from neutral cosmic radiation does not become noticeable at the same altitudes at which it appears to take place at the latitude of Chicago. It would mean that the creation of mesotrons by non-ionizing cosmic radiation in these latitudes should become noticeable at still higher elevations, as would be inferred from temperature co-efficient of the intensity of cosmic rays. The fact that the production of mesotrons by neutral particles at 22° magnetic North does not take place at the same elevation at which it does at 52° magnetic North, would indicate that in the production of mesotrons there is a latitude effect in the sense that at lower latitudes the mesotron producing layer is at greater heights.

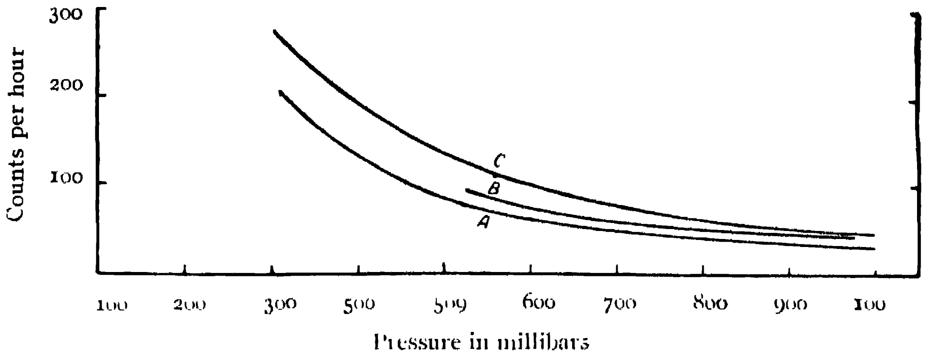

Fig. 2

Curve A—Vertical mesotron intensity at 5.3° N (Bheta, Aiya, Hoteko and Saxena)
Curve B—Vertical mesotron intensity at 22.5° N (Gill and Melaram)
Curve C—Vertical mesotron intensity at 52 5° N (Schein, Jene and Wollan)

The data presented in this paper can be compared with that of Schein, Jesse and Wollan (1940) as well as with that recently published by Bhabha and his collaborators (1945). In fig. 2, curve B represents our results giving the intensity of mesotrons penetrating 8 cm. of lead at 22° N; curve A gives the data of Bhabha and his co-workers at 3.3° N and curve C shows the results of Schein, Jesse and Wollan at 52.5° N. Our results confirm the conclusion drawn by Bhabha and his co-workers that the latitude effect of the penetrating component of cosmic radiation shows a very small increase up to an elevation of 16,800 ft. The accuracy of our data is better than that of others due to the longer time of observation at each elevation.

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